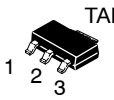
Linear Regulator – Low Dropout, Low I_Q

NCV4264-2C



SOT−223
ST SUFFIX
CASE 318E

The NCV4264−2C is a low quiescent current consumption LDO regulator. Its output stage supplies 100 mA with ±2.0% output voltage accuracy.

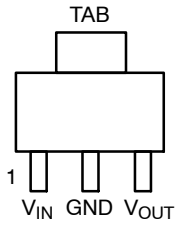
Maximum dropout voltage is 500 mV at 100 mA load current.

It is internally protected against 45 V input transients, input supply reversal, output overcurrent faults, and excess die temperature. No external components are required to enable these features.

Features

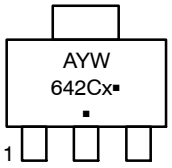
- 3.3 V and 5.0 V Fixed Output
- ±2.0% Output Accuracy, Over Full Temperature Range
- 33 μA Typical Quiescent Current
- 500 mV Maximum Dropout Voltage at 100 mA Load Current
- Wide Input Voltage Operating Range of 4.5 V to 45 V
- Internal Fault Protection
  - −42 V Reverse Voltage
  - Short Circuit/Overcurrent
  - Thermal Overload
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- This is a Pb−Free Device

PIN CONNECTIONS



(Top View)

MARKING DIAGRAM



x	= 5 (5.0 V Version) 3 (3.3 V Version)
A	= Assembly Location
Y	= Year
W	= Work Week
▪	= Pb−Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

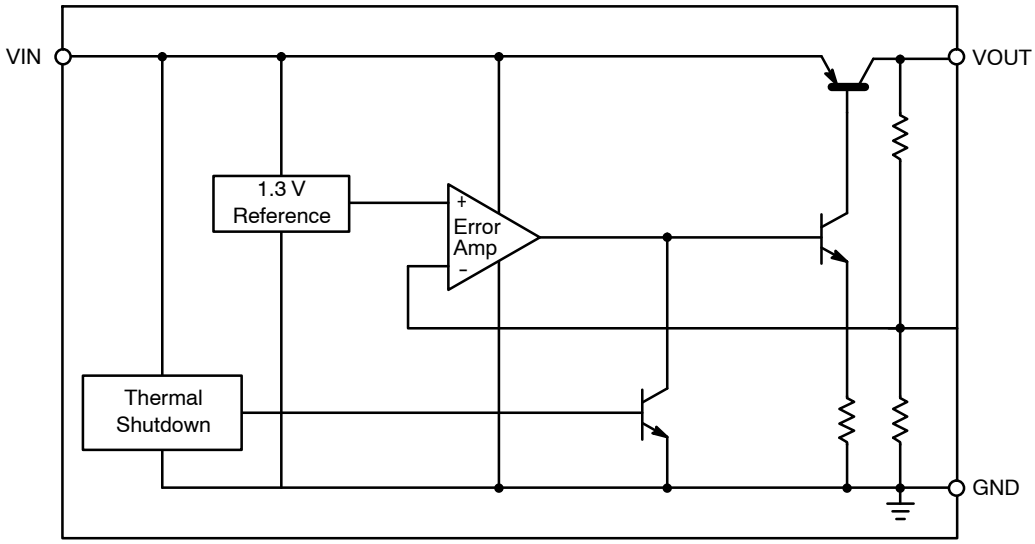


Figure 1. Block Diagram

PIN FUNCTION DESCRIPTION

Symbol	Pin No.	Function
V_{IN}	1	Unregulated input voltage; 4.5 V to 45 V.
GND	2	Ground; substrate.
V_{OUT}	3	Regulated output voltage; collector of the internal PNP pass transistor.
GND	TAB	Ground; substrate and best thermal connection to the die.

OPERATING RANGE

Symbol	Rating	Min	Max	Unit
V_{IN}	V_{IN}, DC Input Operating Voltage (Note 3)	4.5	+45	V
T_J	Junction Temperature Operating Range	−40	+150	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

MAXIMUM RATINGS

Symbol	Rating	Min	Max	Unit
V_{IN}	V_{IN}, DC Input Voltage	−42	+45	V
V_{OUT}	V_{OUT}, DC Voltage	−0.3	+32	V
T_{stg}	Storage Temperature	−55	+150	°C
MSL	Moisture Sensitivity Level	3		−
V_{ESDHB}	ESD Capability, Human Body Model (Note 1)	4000	−	V
V_{ESDMIM}	ESD Capability, Machine Model (Note 1)	200	−	V
T_{sld}	Lead Temperature Soldering Reflow (SMD Styles Only), Lead Free (Note 2)	−	265 pk	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. This device series incorporates ESD protection and is tested by the following methods:
   ESD HBM tested per AEC−Q100−002 (EIA/JESD22−A 114C)
   ESD MM tested per AEC−Q100−003 (EIA/JESD22−A 115C)
2. Lead Free, 60 sec − 150 sec above 217°C, 40 sec max at peak.
3. See specific conditions for DC operating input voltage lower than 4.5 V in ELECTRICAL CHARACTERISTICS table at page 3

THERMAL RESISTANCE

Symbol	Parameter		Min	Max	Unit
$R_{\theta JA}$	Junction−to−Ambient	SOT−223	−	109 (Note 4)	°C/W
Ψ_{JL4}	Junction−to−Tab (psi−JL4)	SOT−223	−	10.9	

ELECTRICAL CHARACTERISTICS (V_{IN} = 13.5 V, T_J = −40°C to +150°C, unless otherwise noted.)

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage 5.0 V Version	5.0 mA ≤ I_{OUT} ≤ 100 mA (Note 5) 6.0 V ≤ V_{IN} ≤ 28 V	4.900	5.0	5.100	V
V_{OUT}	Output Voltage 3.3 V Version	5.0 mA ≤ I_{OUT} ≤ 100 mA (Note 5) 4.5 V ≤ V_{IN} ≤ 28 V	3.234	3.3	3.366	V
V_{OUT}	Output Voltage 3.3 V Version	I_{OUT} = 5 mA, V_{IN} = 4 V (Note 7)	3.234	3.3	3.366	V
ΔV_{OUT} vs. V_{IN}	Line Regulation 5.0 V Version	I_{OUT} = 5.0 mA 6.0 V ≤ V_{IN} ≤ 28 V	−30	0.7	+30	mV
ΔV_{OUT} vs. V_{IN}	Line Regulation 3.3 V Version	I_{OUT} = 5.0 mA 4.5 V ≤ V_{IN} ≤ 28 V	−30	0.57	+30	mV
ΔV_{OUT} vs. I_{OUT}	Load Regulation	1.0 mA ≤ I_{OUT} ≤ 100 mA (Note 5)	−40	0.6	+40	mV
V_{IN}−V_{OUT}	Dropout Voltage − 5.0 V Version	I_{OUT} = 100 mA (Notes 5 & 6)	−	230	500	mV
I_q	Quiescent Current	I_{OUT} = 100 μA T_J = 25°C T_J = −40°C to +85°C T_J = −40°C to 150°C	 − − −	 33 33 33	 55 60 70	μA
$I_{G(ON)}$	Active Ground Current	I_{OUT} = 50 mA (Note 5)	−	0.55	4.0	mA
PSRR	Power Supply Rejection	V_{RIPPLE} = 0.5 V_{P-P}, F = 100 Hz	−	67	−	dB
PROTECTION	**PROTECTION**					
$I_{OUT(LIM)}$	Current Limit	V_{OUT} = 4.5 V (5.0 V Version) (Note 5) V_{OUT} = 3.0 V (3.3 V Version) (Note 5)	150 150	− −	500 500	mA
$I_{OUT(SC)}$	Short Circuit Current Limit	V_{OUT} = 0 V (Note 5)	40	−	500	mA
T_{TSD}	Thermal Shutdown Threshold	(Note 7)	150	−	200	°C

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. 1 oz., 100 mm^2 copper area.
5. Use pulse loading to limit power dissipation.
6. Dropout voltage = (V_{IN}−V_{OUT}), measured when the output voltage has dropped 100 mV relative to the nominal value obtained with V_{IN} = 13.5 V.
7. Not tested in production. Limits are guaranteed by design.

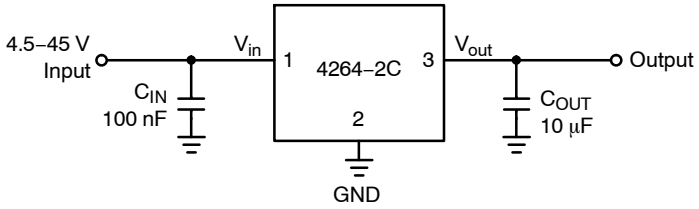


Figure 2. Applications Circuit

TYPICAL CHARACTERISTIC CURVES − 5 V VERSION

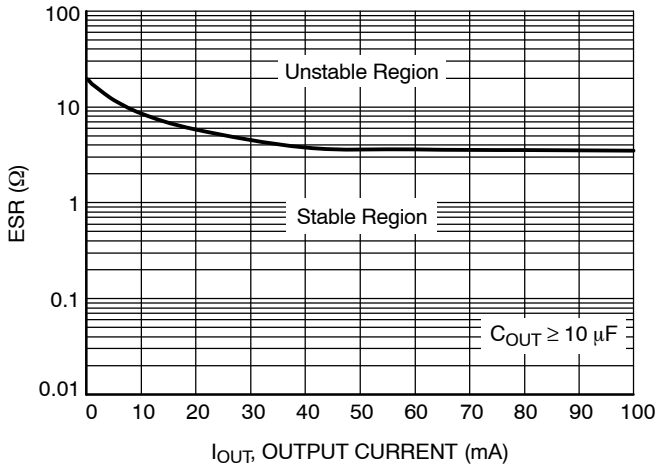


Figure 3. Output Stability with Output Capacitor ESR (5.0 V Version)

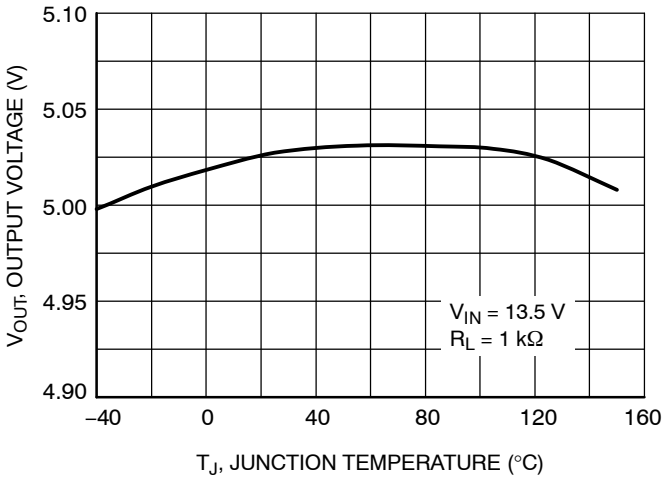


Figure 4. Output Voltage vs. Junction Temperature (5.0 V Version)

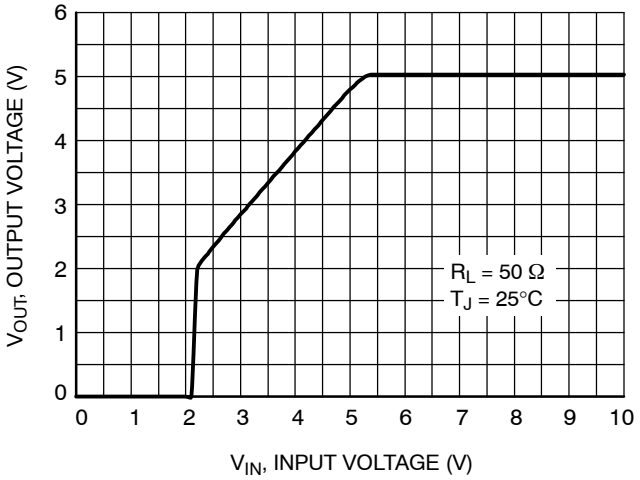


Figure 5. Output Voltage vs. Input Voltage (5.0 V Version)

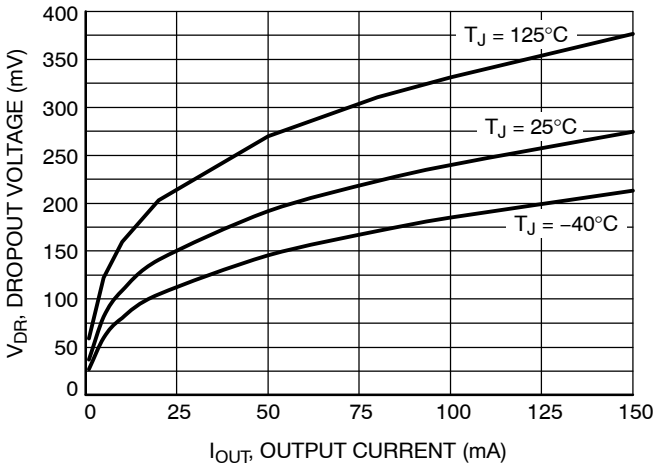


Figure 6. Dropout Voltage vs. Output Current (only 5.0 V Version)

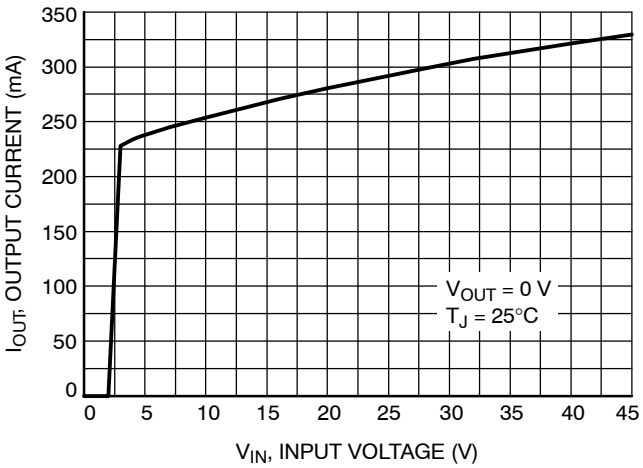


Figure 7. Maximum Output Current vs. Input Voltage (5.0 V Version)

TYPICAL CHARACTERISTIC CURVES − 5 V VERSION (continued)

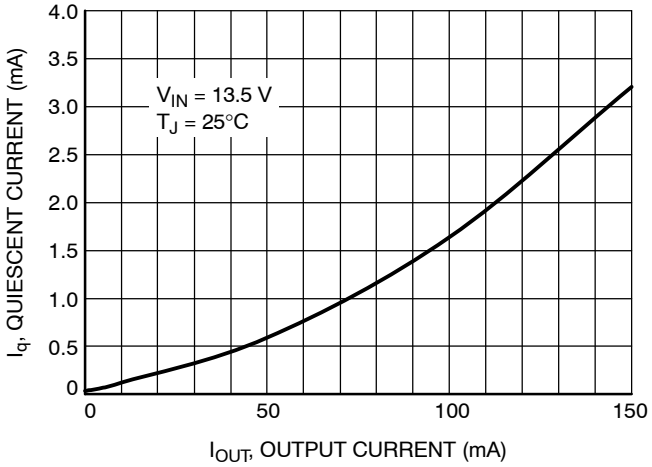


Figure 8. Quiescent Current vs. Output Current (5.0 V Version) (High Load)

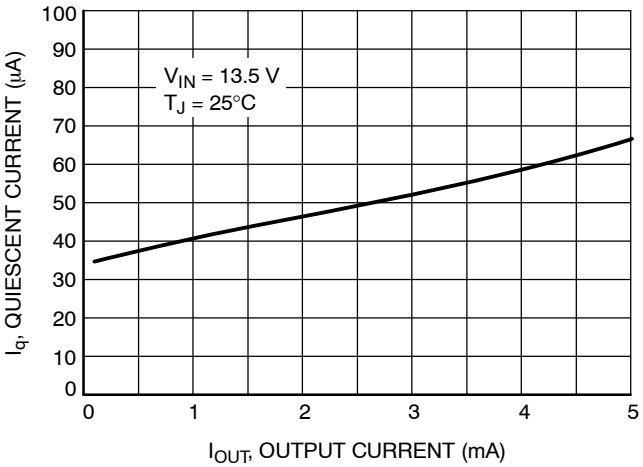


Figure 9. Quiescent Current vs. Output Current (5.0 V Version) (Low Load)

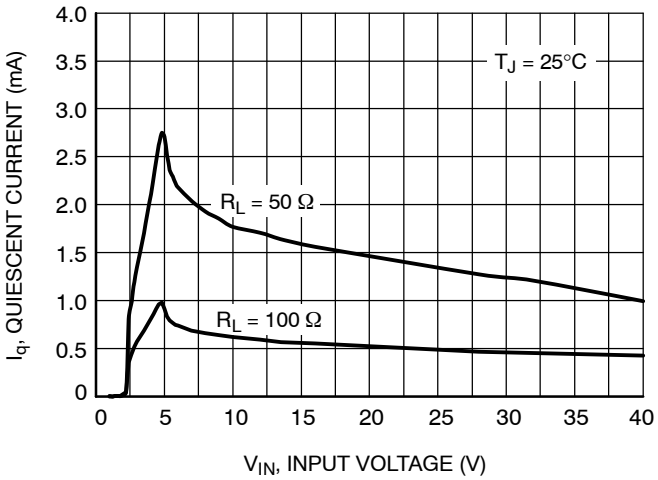


Figure 10. Quiescent Current vs. Input Voltage (5.0 V Version)

TYPICAL CHARACTERISTIC CURVES − 3.3 V VERSION

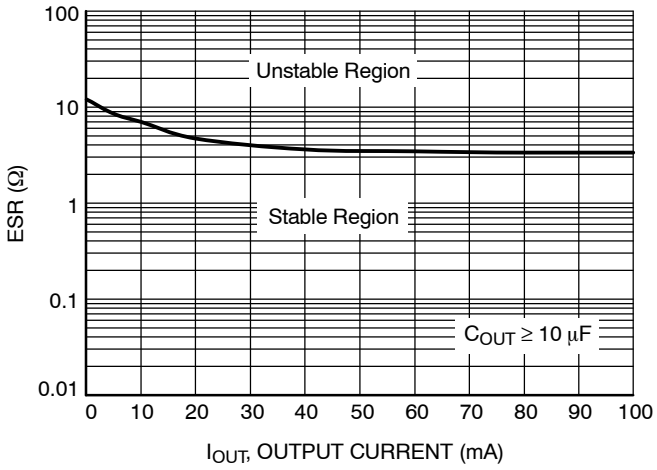


Figure 11. Output Stability with Output Capacitor ESR (3.3 V Version)

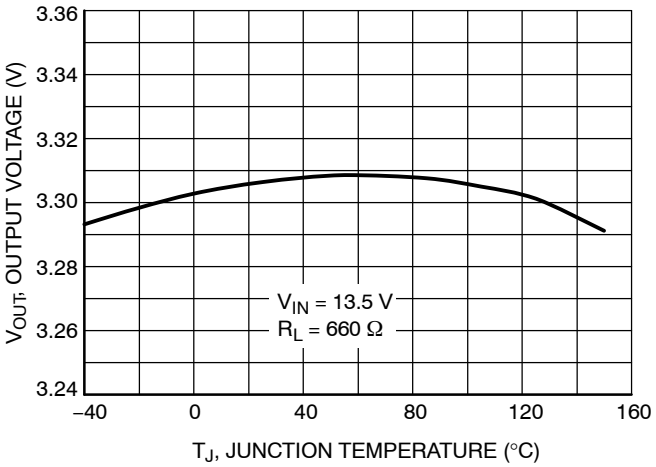


Figure 12. Output Voltage vs. Junction Temperature (3.3 V Version)

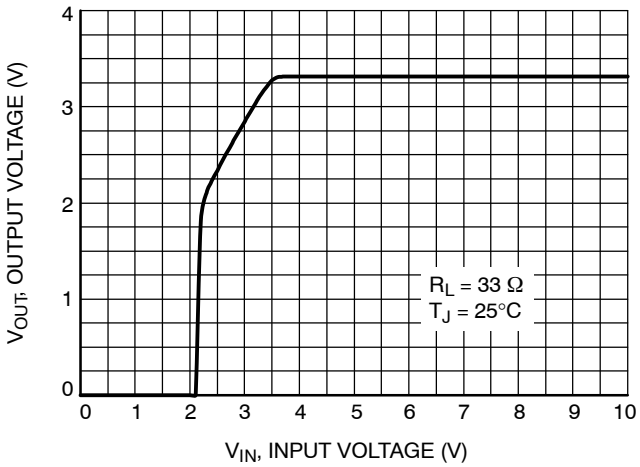


Figure 13. Output Voltage vs. Input Voltage (3.3 V Version)

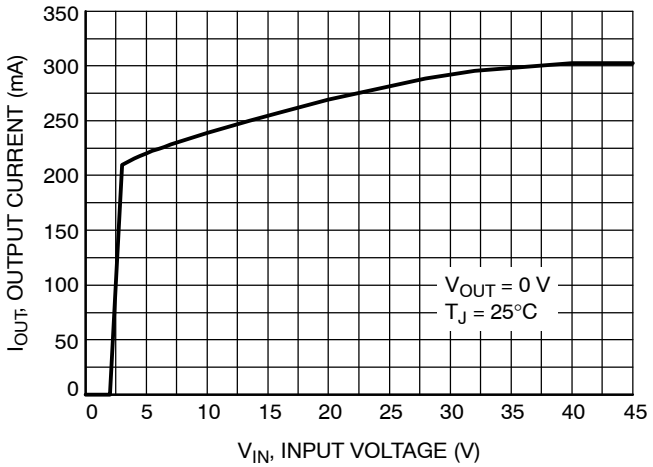


Figure 14. Maximum Output Current vs. Input Voltage (3.3 V Version)

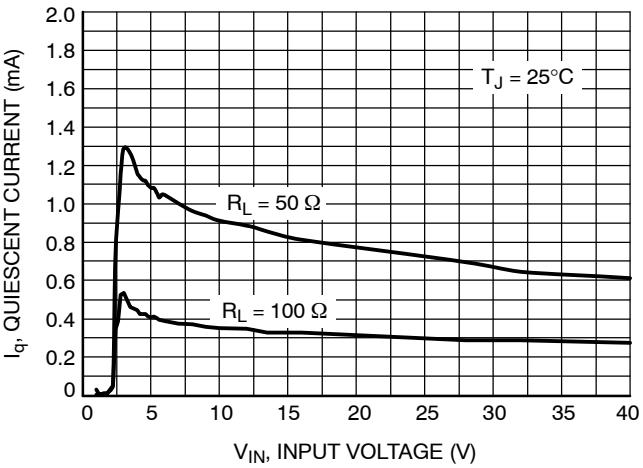


Figure 15. Quiescent Current vs. Input Voltage (3.3 V Version)

TYPICAL CHARACTERISTIC CURVES − 3.3 V VERSION (continued)

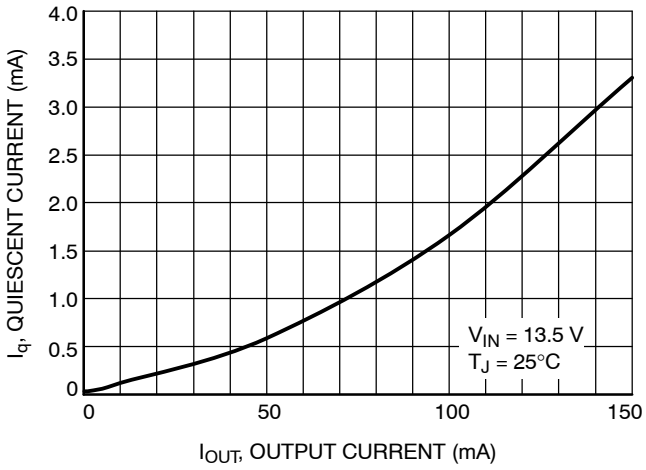


Figure 16. Quiescent Current vs. Output Current (3.3 V Version) (High Load)

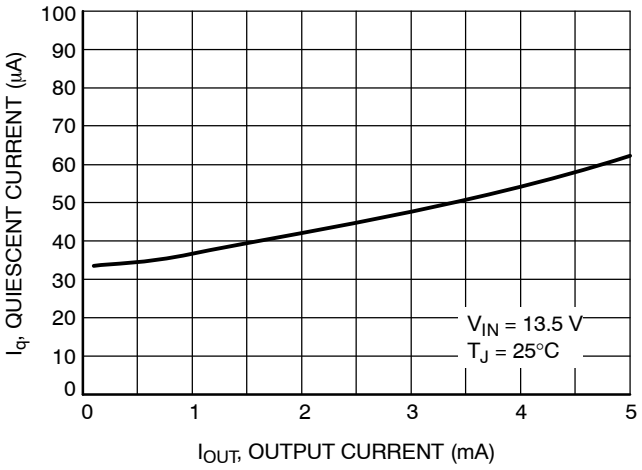


Figure 17. Quiescent Current vs. Output Current (3.3 V Version) (Low Load)

Circuit Description

The NCV4264−2C is is a low quiescent current consumption LDO regulator. Its output stage supplies 100 mA with ±2.0% output voltage accuracy.

Maximum dropout voltage is 500 mV at 100 mA load current. It is internally protected against 45 V input transients, input supply reversal, output overcurrent faults, and excess die temperature. No external components are required to enable these features.

Regulator

The error amplifier compares the reference voltage to a sample of the output voltage (V_{OUT}) and drives the base of a PNP series pass transistor by a buffer. The reference is a bandgap design to give it a temperature−stable output. Saturation control of the PNP is a function of the load current and input voltage. Oversaturation of the output power device is prevented, and quiescent current in the ground pin is minimized.

Regulator Stability Considerations

The input capacitor C_{IN} in Figure 2 is necessary for compensating input line reactance. Possible oscillations caused by input inductance and input capacitance can be damped by using a resistor of approximately 1 Ω in series with C_{IN}. The output or compensation capacitor, C_{OUT} helps determine three main characteristics of a linear regulator: startup delay, load transient response and loop stability. Tantalum, aluminum electrolytic, film, or ceramic capacitors are all acceptable solutions, however, attention must be paid to ESR constraints. The capacitor manufacturer's data sheet usually provides this information. The value for the output capacitor C_{OUT} shown in Figure 2 should work for most applications; however, it is not necessarily the optimized solution. Stability is guaranteed at values of $C_{OUT} \geq 10$ μF, with an ESR ≤ 3.5 Ω for the 5.0 V Version with an ESR ≤ 3.35 Ω for the 3.3 V Version within the operating temperature range. Actual limits are shown in a graph in the Typical Performance Characteristics section.

Calculating Power Dissipation in a Single Output Linear Regulator

The maximum power dissipation for a single output regulator (Figure 3) is:

$$P_{D(max)} = [V_{IN(max)} - V_{OUT(min)}] * I_{OUT(max)} + V_{IN(max)} * I_q \quad \text{(eq. 1)}$$

Where:
$V_{IN(max)}$ is the maximum input voltage,
$V_{OUT(min)}$ is the minimum output voltage,
$I_{OUT(max)}$ is the maximum output current for the application, and I_q is the quiescent current the regulator consumes at $I_{OUT(max)}$. Once the value of $P_{D(max)}$ is known, the maximum permissible value of $R_{\theta JA}$ can be calculated:

$$P_{\theta JA} = \frac{(150^\circ C - T_A)}{P_D} \quad \text{(eq. 2)}$$

The value of $R_{\theta JA}$ can then be compared with those in the package section of the data sheet. Those packages with $R_{\theta JA}$'s less than the calculated value in Equation 2 will keep the die temperature below 150°C. In some cases, none of the packages will be sufficient to dissipate the heat generated by the IC, and an external heat sink will be required. The current flow and voltages are shown in the Measurement Circuit Diagram.

Heat Sinks

A heat sink effectively increases the surface area of the package to improve the flow of heat away from the IC and into the surrounding air. Each material in the heat flow path between the IC and the outside environment will have a thermal resistance. Like series electrical resistances, these resistances are summed to determine the value of $R_{\theta JA}$:

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CS} + R_{\theta SA} \quad \text{(eq. 3)}$$

Where:
$R_{\theta JC}$ = the junction−to−case thermal resistance,
$R_{\theta CS}$ = the case−to−heat sink thermal resistance, and
$R_{\theta SA}$ = the heat sink−to−ambient thermal resistance.

$R_{\theta JC}$ appears in the package section of the data sheet. Like $R_{\theta JA}$, it too is a function of package type. $R_{\theta CS}$ and $R_{\theta SA}$ are functions of the package type, heatsink and the interface between them. These values appear in data sheets of heatsink manufacturers.

Thermal, mounting, and heat sinking are discussed in the **onsemi** application note AN1040/D, available on the **onsemi** Website.

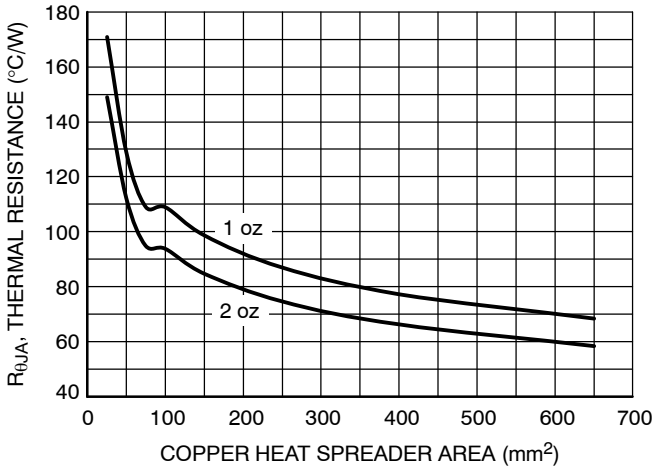


Figure 18. $R_{\theta JA}$ vs. Copper Spreader Area

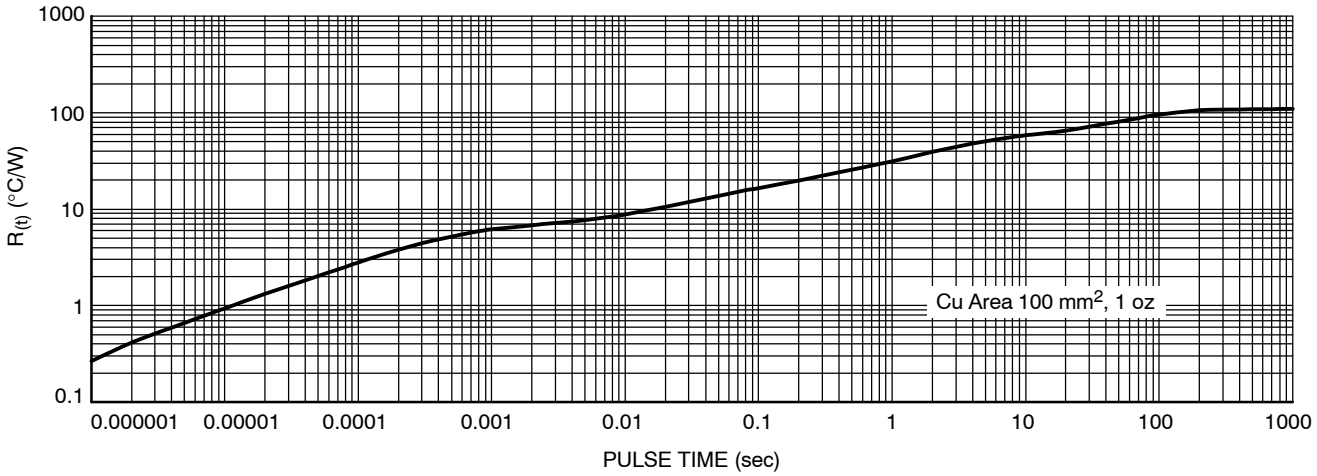


Figure 19. Single Pulse Heating Curve

ORDERING INFORMATION

Device*	Package	Shipping†
NCV4264−2CST50T3G	SOT−223 (Pb−Free)	4000 / Tape & Reel
NCV4264−2CST33T3G	SOT−223 (Pb−Free)	4000 / Tape & Reel

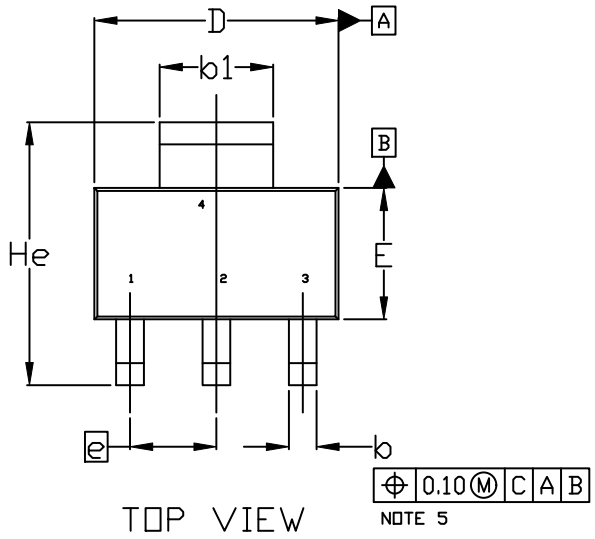
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

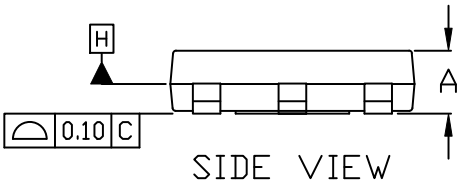
*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable.

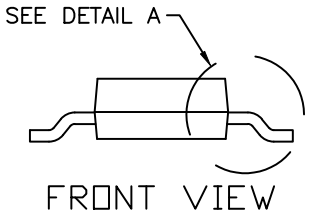
SCALE 1:1

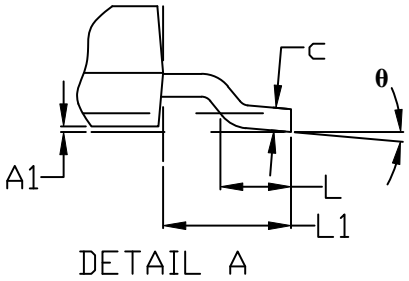
SOT−223 (TO−261)
CASE 318E−04
ISSUE R

DATE 02 OCT 2018



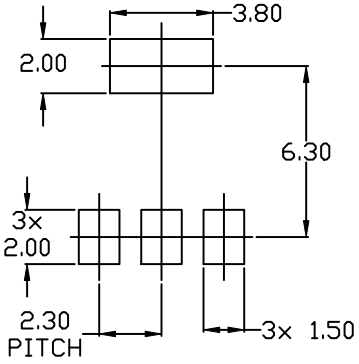






NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS D & E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.200MM PER SIDE.
4. DATUMS A AND B ARE DETERMINED AT DATUM H.
5. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE BODY.
6. POSITIONAL TOLERANCE APPLIES TO DIMENSIONS b AND b1.

	MILLIMETERS		
DIM	MIN.	NOM.	MAX.
A	1.50	1.63	1.75
A1	0.02	0.06	0.10
b	0.60	0.75	0.89
b1	2.90	3.06	3.20
c	0.24	0.29	0.35
D	6.30	6.50	6.70
E	3.30	3.50	3.70
e	2.30 BSC		
L	0.20	---	---
L1	1.50	1.75	2.00
He	6.70	7.00	7.30
θ	0°	---	10°



RECOMMENDED MOUNTING FOOTPRINT

SOT−223 (TO−261)
CASE 318E−04
ISSUE R

DATE 02 OCT 2018

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. ANODE
2. CATHODE
3. NC
4. CATHODE

STYLE 3:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

STYLE 4:
PIN 1. SOURCE
2. DRAIN
3. GATE
4. DRAIN

STYLE 5:
PIN 1. DRAIN
2. GATE
3. SOURCE
4. GATE

STYLE 6:
PIN 1. RETURN
2. INPUT
3. OUTPUT
4. INPUT

STYLE 7:
PIN 1. ANODE 1
2. CATHODE
3. ANODE 2
4. CATHODE

STYLE 8:
CANCELLED

STYLE 9:
PIN 1. INPUT
2. GROUND
3. LOGIC
4. GROUND

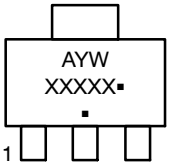
STYLE 10:
PIN 1. CATHODE
2. ANODE
3. GATE
4. ANODE

STYLE 11:
PIN 1. MT 1
2. MT 2
3. GATE
4. MT 2

STYLE 12:
PIN 1. INPUT
2. OUTPUT
3. NC
4. OUTPUT

STYLE 13:
PIN 1. GATE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

GENERIC MARKING DIAGRAM*



A = Assembly Location
Y = Year
W = Work Week
XXXXX = Specific Device Code
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:
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